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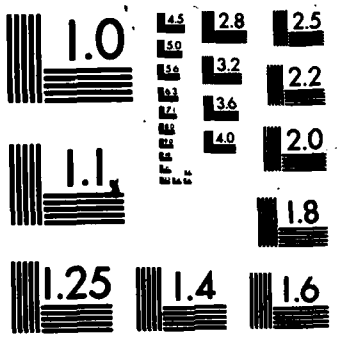

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FOREIGN TECHNOLOGY DIVISION

HEAVY MACHINE-TOOL CONSTRUCTION FOR 50 YEARS

by

V.D. Glukharev, A.V. Sklyarov

UNEDITED MACHINE TRANSLATION

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Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

GRAPHICS DISCLAIMER

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HEAVY MACHINE-TOOL CONSTRUCTION FOR 50 YEARS.

V. D. Glukharev, Chief of the central board of the Ministry of Machine-tool and Tool Industry.

A. V. Sklyarov, Chief engineer of the Ulyanov plant of heavy machine tools.

In pre-revolutionary Russia the machine-tools construction was not an independent branch. The plants, which manufactured machine tools, imported parts and whole assemblies of machine tools from abroad and were carried out only assembly or installation, placing on the machine tool its brand/mark.

In 1930 the question about the purchase outside the boundary/interface of the large vertical turret lathes, supplier of which on the world market in essence was Germany, came up. Were stocked up the vertical turret lathes with a diameter of from 3 to 8 m and the largest of them, machine tool of firm Schiss-Defries of Dusseldorf, model 7CK-920 with a greatest diameter of processing 9200 mm and weights of 477 t. This machine tool was obtained into 1933 and established/installed at the Kharkov turbogenerator plant (KhTGZ).

Since 1931-1932 with an increase of the difficulties of obtaining the machine tools in the capitalist countries a question about the need organizing the production of heavy machine tools within the country increasingly more sharply/acutely is raised.

The history of the production in the USSR of heavy planing machines should be considered with 1931 when the Leningrad machine-tool plant im. Sverdlov was released the planing machine of model ZPS with the sizes/dimensions of workpiece to 1000×3000 mm and

a weight of 14.2 t. For that time this was the modern construction/design with electromagnetic coupling of switching the direction of the motion of table, sufficiently high cutting speeds, which contributed to the wide popularity of this machine tool in the pre-war period.

The people's commissariat of heavy industry affirmed standards to the single-column and two-strut planing machines. In 1933 the plant im. Sverdlov mastered machine tool 2ПС with the sizes/dimensions of workpiece 1000×2000 mm, while in 1934 - machine tool ZAS with the sizes/dimensions of workpiece 1500×4000 mm. In 1933 in the USSR was initiated preparation/training for the design of larger/coarser heavy machine tools.

To the Leningrad metal-working plant (LMZ), to which there was denied in the delivery on the export of necessary 12-meter vertical turret lathe, it was proposed to manufacture it by its forces. In 1933 the drawing/draft at the Kharkov turbogenerator plant (KhTGZ) of the vertical turret lathe 7CK-920 with a diameter of 9200 mm is manufactured.

Further development of the working drawings of nine-meter vertical turret lathe, initiated on LMZ, was transmitted to the section of the industrial design of scientific research institute,

Leningrad industrial institute im. Kalinin. Working project to the first nine-meter Soviet vertical turret lathe was developed by the group of instructors of LII together with the designers of the plant im. Karl Marx and "Elektrosila" (Leningrad) in 1934-1936.

To machine tool was appropriated model K-159, its basic technical data: the greatest diameter of processing 9200 mm; the greatest height/altitude of processing article 5000 mm; the greatest permissible weight of article 170 t; the greatest permissible total force of cutting 20 t; the greatest stroke of slider of support 3700 mm; the limits of the numbers of revolutions of face chuck 0.17-7.5 r/min; the limits of supplies 0.20-60 mm/rev; the power of main drive 150 kW; the weight of machine tool 500 t; a quantity of established/installed on the machine tool electric motors (including generators) 11.

The manufacture of this machine tool was initiated at several Heavy Machine Building Plants by way of cooperation. At this time is initiated the design of the Ural Heavy Machine Building Plant in Sverdlovsk, where subsequently it was proposed to manufacture such machine tools.

For the preparation of the production of the first heavy machine tools in 1935 the industrial-technological division of future plant

in Urals is organized in Leningrad.

In 1936 Leningrad branch of ENIMS was eliminated and transmitted into that organized then the division of heavy machine-tool construction in the plant TsENTROLIT in Leningrad.

After the cessation/discontinuation of the building of plant in 1937 division of heavy machine-tool construction it was reorganized into independent central bureau of heavy machine-tool construction (TsBTS) in Leningrad, which took upon itself, besides designing for the heavy vertical turret lathes, the development of technology, conduct of machine tools in the production and dispatching works on the manufacture of vertical turret lathes by way of cooperation on Novo-Kramatorsk the Heavy Machine Building Plant, where were manufactured the base parts: base/root, face chuck, toothed rim and cross-beam.

On KhTGZ was performed the turning of the parts of base/root and face chuck on the only then in the country nine-meter vertical turret lathe. At the Ural Heavy Machine Building Plant were manufactured and machined the struts, the sliders of supports and the bevel gears with the diameter of 1350 mm. Main drive was manufactured on the only then in the country the machine tool Orlikon for working of the cogged bevel wheels of such sizes/dimensions; on with Staro-Kramatorsk plant

were manufactured the plates/slabs under the struts; plant "Elektrosila" in Leningrad performed the treatment of the housing of the reducer of main drive; Gor'kiy motor vehicle plant manufactured the large part of gears and others relative to fine details - a total of about 600 designations; Leningrad metal-working plant, plant "Russkiy dizel'" in Leningrad, machine tool construction plants im. Sverdlov, "Krasnyy Proletariy", im. Ordzhonikidze, Gor'kiy plant of milling machines and plant "Dvigatel' revolyutsii" in Kalinin, Tula, Leningrad (a total of more than 40 enterprises and workshops) also were manufactured different parts to the heavy machine tools.

The first test batch was ordered of three machine tools. However, it was soon explained that different clients impose different requirements on machine tools, that the machine tool for LMZ must be below in conformity with the height/altitude of crane runways, that for Novo-Kramatorsk plant is necessary the machine tool with the possibility of processing parts by a diameter of up to 12 m, and to Arkhangel'sk plant it is necessary the machine tool of the same height/altitude, that also for LMZ, but with processing of parts the diameter of 12 m and, furthermore, it is compulsory with the ram head.

In 1937-1940 designs of the machine tool K-159 TsBTS reworked and gave out drawings to the machine tools of three different models: УК-159 for the Leningrad metal-working plant with the shortened supports; МК-159 for Novo-Kramatorsk plant (this machine tool later was re-addressed also for LMZ) with the branch/removal of portal for an increase in the diameter of processing to 13300 mm; КБ-159 for the Arkhangel'sk plant - with the shortened supports, the branch/removal of portal and the ram head.

After the termination of the treatment/processing projects was produced technological preparation/training, orders at the plants were placed, and then in transmitted TsBTS over the areas of plant "TsENTROLIT" was organized and produced by forces of TsBTS the assembly of the units of the first machine tool.

The general assembly of the first machine tool and its installation on their constant foundation they conducted directly in client - LMZ; the assembly also of the second machine tool was there initiated. At first works conducted by forces of TsBTS and were completed by the plant im. Sverdlov, into composition of whom were transferred all productive - technological services TsBTS.

The assembly of the basic units of machine tool is initiated during May 1940. The general assembly of machine tool is initiated

during October 1940. During December the machine tool was assembled and underwent by this time all preliminary tests, which were conducted during its manufacture and installation of units. After the termination of the tests of plant board the machine tool was given to the state acceptance commission on 7 March 1941 and, until now, is in operation on LMZ. The termination of the manufacture of other two machine tools of the models of MK-159 and KB-159 was stopped in connection with the begun Great Patriotic War.

The accumulated experiment in the area of the production of planers allowed the Leningrad plant im. Sverdlov as long ago as 1939 to begin the development of the standardized series/row of single-column and two-strut planing machines with the sizes/dimensions of workpieces from 1000×2000 to 1500×5000 mm. Simultaneously occurred the design of planers with a width of processing by 2000; 2500 and 3000 mm on by Kramatorsk the plant of heavy machine tools.

That beginning of soldier also inhibited further improvement of the constructions/designs of planing machines. Both plants (Kramatorsk ZTS and Leningrad im. Sverdlov) were evacuated into the deep rear - into Novosibirsk, where among the bare steppe under severe conditions of wartime was created the new giant of heavy machine-tool construction - plant of heavy machine tools and

large/coarse hydropresses "Tyazhstankogidropress [Heavy Machine Tool and Hydraulic Press Plant]".

On the eve of the Great Patriotic War at different plants of the country the production of the heavy machine tools of different types was also initiated.

In 1939 at the Moscow plant "Krasnyy proletariy" is released the lathe 1Д65 with the height/altitude of the centers of 500 mm and distance between centers 5000 mm. Plant "Dvigatel' revolyutsii" (Gor'kiy) manufactured wheel-turning machine tool with the height/altitude of the centers of 950 mm and distance between centers 2700 mm. The plant im. Sedin (Krasnodar) in 1940 manufactured two-strut turning-and-boring machine tool with a diameter of processing 2000 mm.

On the Kharkov machine-tool plant in 1939 radial drilling machine largest/coarsest for those times is released with the drilling capacity in steel 75 mm.

The Leningrad plant im. Sverdlov before the war was only in the USSR which constructed the horizontal boring machines and produced in the period of the second and third five-year plans machine tools with a diameter of the shaft of 80 mm.

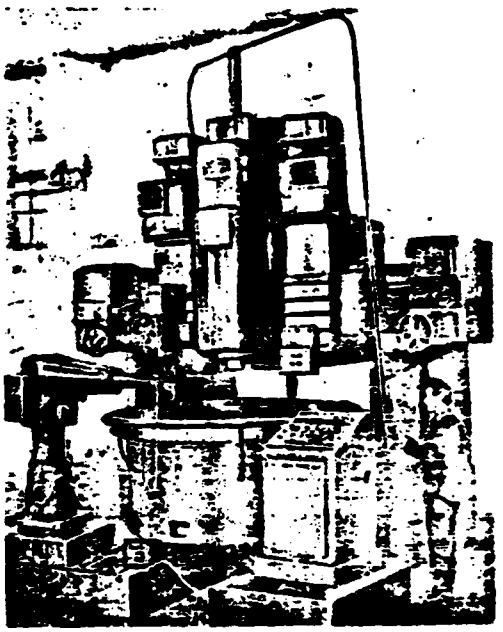

Fig. 1. Turning-and-boring lathe HX5.

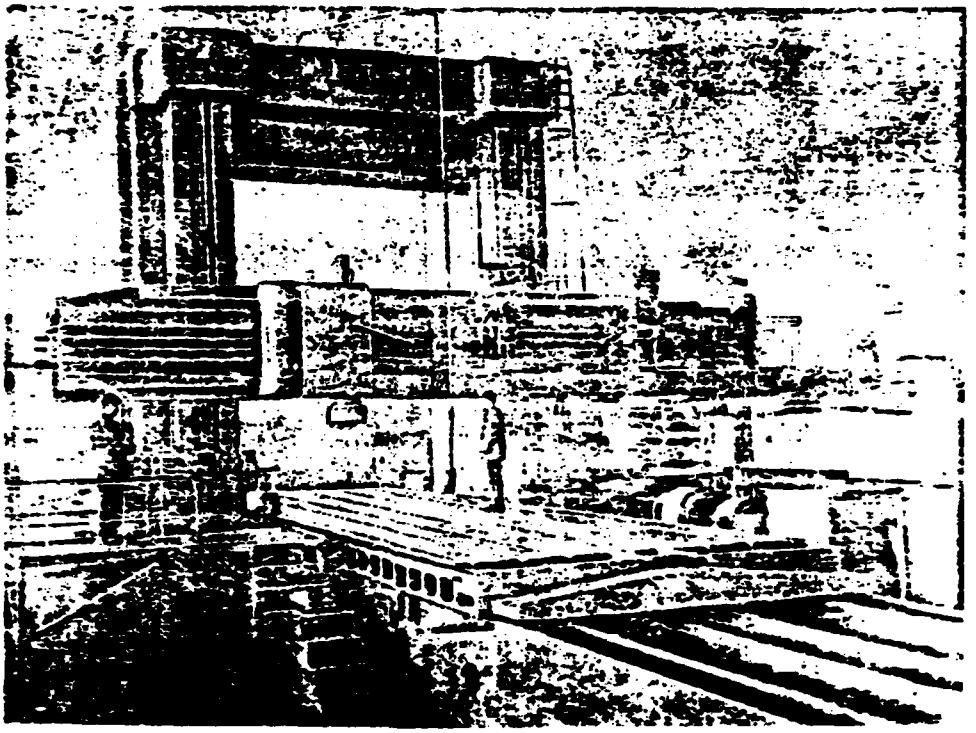

Fig. 2. Planing machine 7278.

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In 1941 plant began the adoption of the range of boring machines with diameter of spindle from 80 to 150 mm and had time to release prior to the beginning of the war horizontal-boring machine tool with a diameter of spindle 110 mm for the boring of holes with a diameter of up to 500 mm.

The Gor'kiy plant of milling machines (GZFS), which entered into

the system in 1932, was the basic plant for the production of milling machines before the war. Heavy straight-line milling machines GZFS began to manufacture in 1939, in particular, longitudinal-milling quadruple machine tools with the size/dimension of table 900×3250 mm.

The Kramatorsk plant of heavy machine tools was the country's first plant, intended for the production of the machine tools of the largest sizes/dimensions. Before the war it began the production of roll-turning machines of machine tools for a deep drilling. Then plant began the production of heavy lathes with the height/altitude of centers to 2000 mm, turning-and-boring lathes with a diameter of processing of up to 5000 mm.

From the given above incomplete enumeration of the heavy machine tools, released in the prewar period it is apparent that the bloom of heavy machine-tool construction falls for the years of the third five-year plan. War prevented further development of heavy machine-tool construction. Many plants, which produce heavy machine tools, fell on the territory occupied.

The basic frames/personnel of designers were concentrated at the constructed by Novosibirsk plant "Tyazhstankogidropress", whose building for the resolution of government was initiated during the heaviest years of war - in 1942.

The production of vertical turret lathes at NZTG was initiated from the single-purpose machines with a diameter of up to 2500 mm, designed in 1942-1943 (Fig. 1). In 1943 here was begun the development of the drawings of the new planing machine of the model of 724 original constructions/designs, correspond to the latest achievements of Soviet and world machine-tool construction. That mastered by production in 1948 machine tool was characterized by the high cutting speeds and back stroke (to 60 m/min), high rigidity and vibration resistance. The contemporary drive of machine tool provided the maximum force of cutting - to 800 kgf, which created conditions for the highly productive work on machine tool.

During December 1948 in Novosibirsk was mastered the two-strut plano-milling machine of model 7256 with the sizes/dimensions of workpieces to 2000×6000 the mm. machine tool it had even higher cutting speeds - to 75 m/min, and the cutting force increased to 15000 kgf. The mastery/adoption of these machine tools marked new page in the production of heavy planing machine tools with itself.

Soviet machine-tool makers switched over to the creation of the original Soviet constructions/designs, which correspond to the level of development of world technology. The examination/inspection of

planing machine tools, carried out in 1951-1952, showed that the new machine tools according to the precision/accuracy, ease of control, technical characteristic are not inferior to foreign, and in the productivity they considerably exceed them.

.The mastery/adoption of the production of the planing machines of smaller size/dimension at the Machine Tool Building Plant restored/reduced after war by Minsk simultaneously in the postwar years went.

During July 1952 by Novosibirsk plant "Tyazhstankogidropress" was released planing machine 7278 (Fig. 2) with the sizes/dimensions of workpiece to 3000×8000 mm and a weight of up to 45 t. The mastery/adoption of the gamma/range of unique planing machines was begun with the production of this machine tool. While the machine tool of model 7278 had a weight of 130 t (almost nine times more than the first, released into the USSR, the planing machine of model ZPS), the unique combined longitudinal-milling-planing machine tool 7288Ф (Fig. 3) familiar in 1954 was the weight of already 350 t. It could work the parts with size/dimension to 4000×12000 mm and with weight to 100 t. On the table of this machine tool freely was placed the first-born of the postwar production of planing machines - machine tool 724M.

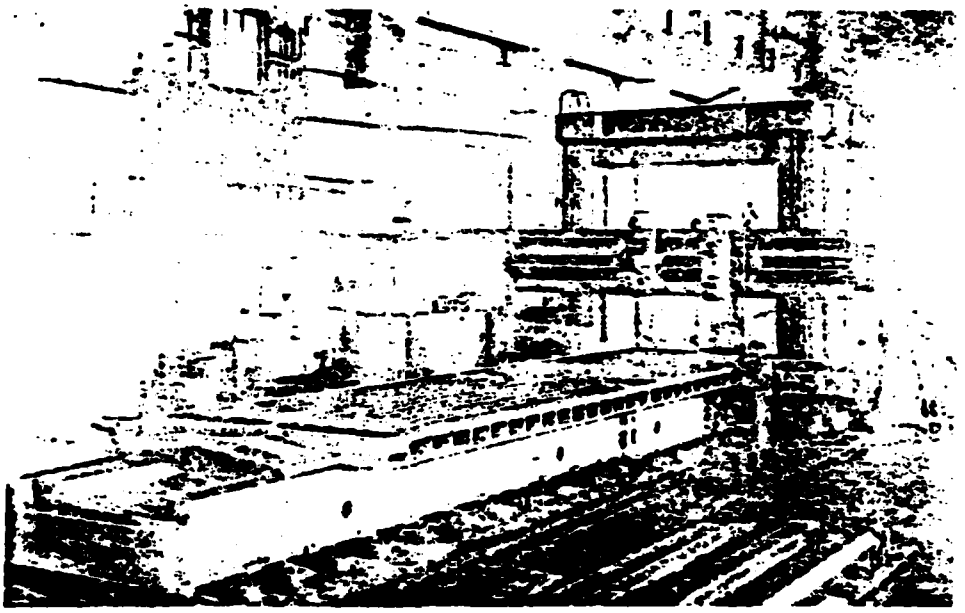

Fig. 3. Combined longitudinal-milling-planing machine tool 7288Ф.

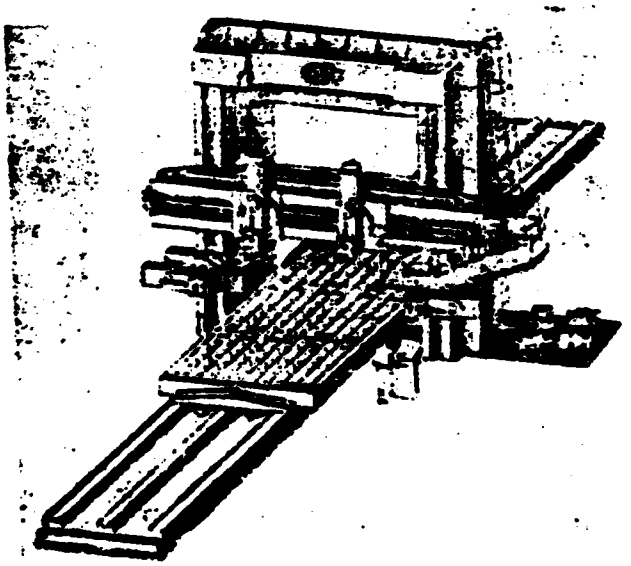

Fig. 4. Planing machine 7289.

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In 1957 there was the scan the experimental model of planing machine 7289 (Fig. 4) with the sizes/dimensions of workpiece 5000×15000 mm not only of the largest of longitudinal-working machine tools in the USSR, but also one of the large ones in the world.

In the production of the types of machine tools indicated was widely used interdimensional unification - all three types of machine tools had identical gearboxes, main drive, worm reducers, etc. All this considerably accelerated the mastery/adoption of machine tools in the metal.

On the decision of the CC CPSU and SM of the USSR from second January 1945 to plant "Tyazhstankogidropress" is charged the manufacture of vertical turret lathes. In three months the technical design of machine tool and working drawings to the base parts were developed, and during April 1945 technical project was affirmed in Moscow by the minister of machine-tool construction A. I. Yefremov. During August 1945 working project was completed. Model 157 (Fig. 5) was appropriated to machine tool. Its basic technical data: the greatest diameter of processing 7000 mm; the greatest height/altitude

of processing is 4000 mm; the greatest weight of workpiece 150 t; the weight of machine tool 350 t. However, the manufacture of machine tool was tightened and the first sample/specimen was manufactured only in 1951. They soon manufactured the second machine tool. Then the production of heavy turning-and-boring machine tools was transmitted to the Kolomna plant of heavy machine-tool construction.

The Novosibirsk plant "Tyazhstankogidropress" for the first time in the country began the production of heavy and unique horizontal boring machines with a diameter of shaft of from 150 mm and it is above.

In the postwar years by plant was produced by the horizontal boring the machine tool 265B with a diameter of the shaft of 150 mm. Toward the end of the 50's this model no longer corresponded to contemporary requirements.

In 1952 the experimental model of the horizontal boring machine with the table with a diameter of the shaft of 150 mm is released. In the construction/design of machine tool are laid the fundamentally new solutions: the adjustable drive of direct current both for the advance and for working motion - the rotation of shaft, in the machine tool there was no customary gearbox, control completely was accomplished/realized from pendant push-button station. This was the

country's first experiment with pendant push-button station for control.

The development of the standardized range of heavy horizontal boring machines with a diameter of the boring bar of 200 mm (led subsequently to 220 mm), 250 and 320 mm simultaneously was led by the designers of OGK of plant. Machine tool with a diameter of the shaft of 320 mm had to become the largest horizontal boring machine in the world.

Having experiment on the machine tool of model 2652, the designers of plant went completely originally. For the first time in the practice of the creation of boring machines all controls of machine tool (lever, flywheels, etc.) were abolished and generally on the machine tools it did not become the controls, which require the application of physical force.

All machine-tool controls it was concentrated on pendant push-button station for original construction/design. Panel, in turn, had a freedom of motion in all directions and provided machine-tool control from any place in the zone of processing parts, including the stage of the boring head.

Main drive has four mechanical velocity changes, between which a

change in the numbers of revolutions is produced steplessly with the aid of the adjustable electric motor of direct current. Gear shift is remote/distance from pendant push-button station by means of the electrohydraulic system.

A change in the rates of feeds is also produced from pendant push-button station over a wide range steplessly in the process of cutting. These measures sharply built up the productivity of machine tools by the maximum use of possibilities of instrument and machine tool under the changing conditions of cutting during working of article.

In the machine tool the remote/distance reading of displacements is provided for also. The scales of reading are placed on pendant push-button station. All auxiliary operations on the machine tool are automated and mechanized.

In 1953 plant manufactured the first sample/specimen of machine tool from the new range of model 2660 with a diameter of the boring bar of 200 mm.

Fig. 5. Turning-and-boring lathe 157.

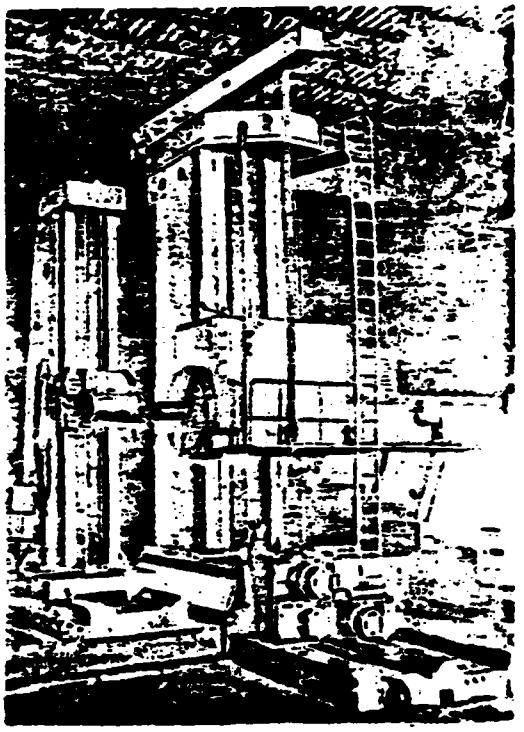

Fig. 6. Horizontal boring machine 2670.

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In 1955 machine tool 2670 (Fig. 6) with a diameter of the boring bar of 250 mm is manufactured, and year later model 2680 with a diameter of the shaft of 320 mm. The weight of latter-machine tool was 230 t; this was the machine tool largest in the world.

The horizontal boring machines after the small modernization of models 2A660, 2A670 and 2A680 are produced by NZTSG on the present

day and enjoy large demand not only in our country, but also abroad.

The short technical characteristics of these machine tools are given below:

In 1948 began to release machine-tool production the Kolomna plant of heavy machine-tool construction. Plant specialized in the production of the turning-and-boring lathes with a diameter of processing of from 3200 mm and it is above, whose production was transmitted from the Novosibirsk plant "Tyazhstankogidropress". Was simultaneously initiated the production of heavy gear-cutting machine tools, in a number their machine tools for the thread of the teeth on the gears with a diameter of up to 12000 mm. At the plant was subsequently mastered the issue also milling, of slotting ones and other types of heavy machine tools.

The development of the constructions/designs of the turning-and-boring lathes with a diameter of processing by 3200; 4000; 5000; 6300 and 8000 mm was charged to Kolomna SKB-4, and heavy and unique machine tools with a diameter of 6300; 8000; 10,000; 12,500; 16,000 and 20,000 mm to the branch СКБ-4, on base of which was soon organized Ulyanov GSKB (main special designer bureau) of heavy and milling machines, available at one time СКБ-11.

From developed by Ulyanov GSKB of the standardized range of the turning-and-boring lathes Kolomna ZTS were manufactured the machine tools of models 1570 with the diameter of processing 6300 mm, weights of machine tool 330 t, 1591 t with the diameter of processing 10000 mm, weights of machine tool 560 t and 1594 with a diameter of processing 16000 mm, and with the moved aside portal 22,000 mm, the weight of machine tool 1400 t.

Of all enumerated machine tools by the largest vertical turret lathe and the generally largest machine tool, manufactured in the USSR, is the machine tool of model 1594 (Fig. 7). According to its sizes/dimensions and driving power this machine tool corresponds to the largest machine tools in the world, released by firm Shiss-Defriz.

Its basic technical data: turning diagram in the normal position of portal 16,000 mm; the same with the diverted portal 22,000 mm; the greatest height/altitude of workpiece 6300 mm; the diameter of circular face chuck 14,000 mm; central of 7500 mm; the greatest weight of article for the circular face chuck 260 t, for the central - 140 t; the number of revolutions of circular face chuck 0.0013 - 3 r/min, by central 0.20 - 12 r/min; the power of main drive 420 kW; the total number of electrical machines, established/installed on the machine tool (electric motors, generators, etc.) 106; the total weight of

machine tool with the electrical equipment 1400 t.

Machine-tool control is completely centralized is accomplished/realized from the central control panel or from the panels, arranged/located on the supports. A change in the number of revolutions of face chuck and rates of the feeds of supports is accomplished/realized steplessly from the control panel. On the machine tool accomplishing copying works is possible which is very important during processing of shaped bodies of revolution. With the aid of the milling slide possible to produce milling, boring and boring works without the rearrangement of heavy workpieces to another machine tool. All auxiliary operations on the machine tool are automated and mechanized.

The manufacture of this machine tool-giant, which exceeds machine tools of firm Shiss known to entire peace/world, on its performing characteristics derived the Soviet Union in the first place in the field of the creation of the heavy machine tools largest/coarsest in the world.

To the fiftieth anniversary of the Soviet regime workers, the engineers technology, that work in the region of heavy machine-tool construction, can with the pride state that today there is not one country in the world, which has available in the region of heavy

machine-tool construction this material base and fixed capital, such as we have available. According to a number of heavy machine tools, according to their maximum characteristics our country occupies the first place in the world now.

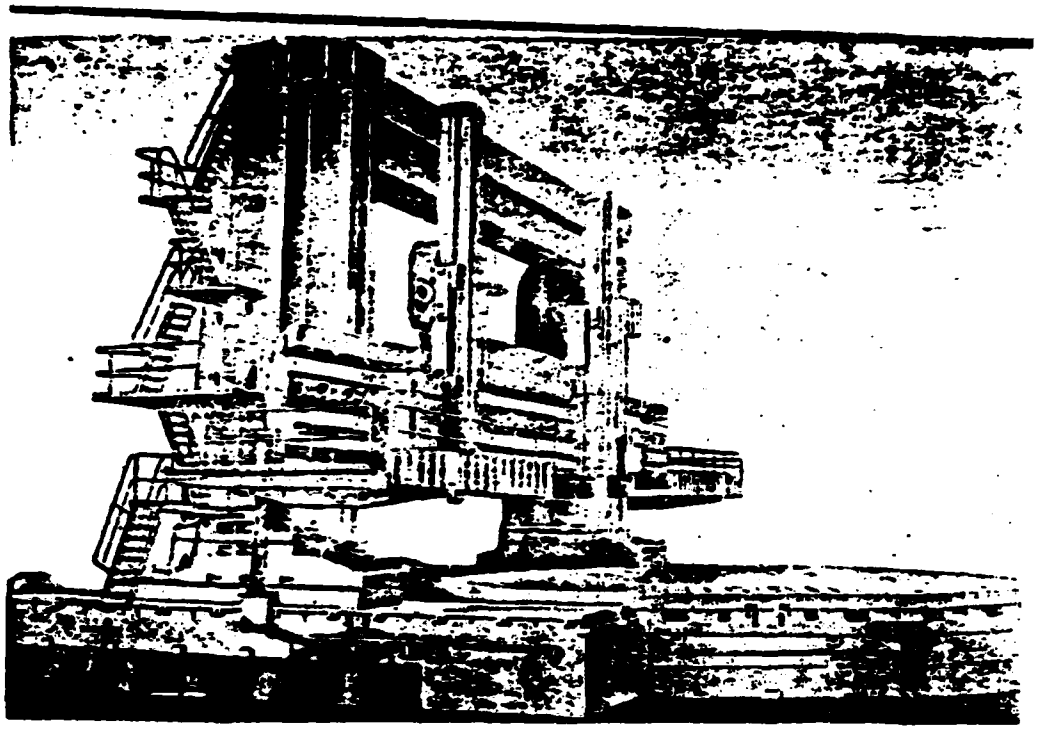

Fig. 7. Turning-and-boring lathe 1594.

Показатели (1)	2А [illegible]	2А [illegible]	2А [illegible]
Диаметр расточного шпинделя в *мм* (2)	220	250	320
Диаметр планшайбы в *мм* (3)	1150	13[illegible]	1500
Мощность электродвигателя главного привода в *квт* (4)	45	88	88
Пределы чисел оборотов шпинделя в *об/мин* (5)	4—450	3—350	2—250
Пределы подач стойки в *мм/мин* (6)	12—1200	10—600	10—600
Пределы подач шпинделя в *мм/мин* (7)	3—300	3—300	3—300
Вес станка в *т* (8)	112	180	230

Key: (1). Indices. (2). Diameter of the boring bar in mm. (3). Diameter of face chuck in mm. (4). Power of the electric motor of main drive in kW. (5). Limits of the numbers of revolutions of shaft in r/min. (6). Limits of the supplies of strut in mm/min. (7). Limits of the supplies of shaft in mm/min. (8). Weight of machine tool in t.

END

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